ROCK DUSTING AND SAMPLING

INCLUDING WET ROCK DUSTING, AT THE BUREAU OF MINES EXPERIMENTAL COAL MINE

By Irving Hartmann and James Westfield

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INTRODUCTION

Modern mechanized mining with high-speed machines, multiple-entry systems, multiple blasting, high-velocity air currents, and rapid haulage has brought many economic benefits and has on the whole enhanced safety in the coal-mining industry. It has, however, also introduced some added hazards, the control of which requires concerted effort and ingenuity. Mechanized mining has greatly increased the production and dissemination of fine coal dust in mine entries. Use of high-speed machines has increased the probability of formation of incendive sparks, which are produced by frictional contact between moving metals and certain mineral substances in the coal seam or in the adjoining rock strata. In gassy seams rapid extraction of coal has increased the rate of gas evolution.

These facts have made more urgent the need of preventing the ignition of coal dust and the development of widespread mine explosions. The ignition hazard can be controlled best by eliminating all potential igniting sources and by careful attention to ventilation designed to prevent accumulation of gas capable of triggering a coal-dust explosion. Frictional spark ignition by mining machines and suggested safeguards are discussed in a recent publication.3/ Extensive research and long experience have shown conclusively that the propagation of coal-dust flames can be arrested and the development of widespread explosions prevented by properly applied, generalized rock dusting.

EFFECTIVE ROCK DUSTING

Unlike mine gas, which normally occurs only near active faces, in caved gob areas, and occasionally in limited volume at other points in a mine, combustible coal dust may be present on all surfaces in sufficient quantity to produce explosive dust clouds.

To be effective, rock dust must be applied uniformly and continuously on the rib and roof surfaces as well as on the floor of coal-mine entries. The rate of application must be adequate to raise the incombustible content of the mine dust to a minimum of 65 percent.

Before rock dust is applied in a mine entry initially, all excessive coal dust, loose coal, and other combustible material must be removed from the area. This reduces the required amount of rock dust, facilitates mixing of the rock dust with the coal dust, and reduces the fire hazard.

Experiments have shown that coal-dust explosions in the mine entries can be quenched most successfully near their point of origin. Since most ignition sources occur at and near active coal faces, rock dusting in active entries must be carried as close to the face as possible, in any case, at least to within 40 feet.

3/ Hartmann, Irving, Frictional Ignition of Gas by Mining Machines: Bureau of Mines Inf. Circ. 7727, 1955, 17 pp.

In operating mines fresh coal dust is produced at the active faces and by rib spalling, and dust is transported by the air currents during the active life of a mine. To neutralize this fresh dust on the mine surfaces, it is necessary to apply additional rock dust from time to time. An old but still valid recommendation is to rock-dust little but often. This promotes the mixing of rock dust with coal dust and makes rock dusting more effective.

The Bureau of Mines recognizes that, to comply with the foregoing requirements for effective rock dusting, many coal-mine operators face economic and technical difficulties. This is true, especially in mines where little if any rock dusting was practiced until recent years when it became compulsory and in mines where coal faces advance very rapidly. A primary objective of this report is to outline suggested remedies for some of the difficulties. Before doing this it is advisable to discuss another factor, which has been a very great deterrent in the effective application of generalized rock dusting; this is the apparently widespread misinformation concerning the role of rock dusting in mine explosions.

MISCONCEPTIONS REGARDING ROCK DUSTING AND EXPLOSIONS

Following are several erroneous ideas regarding the action of rock dust and the development of mine explosions, and brief comments concerning each:

(1) Fallacy: Dormant rock dust on the mine floor and elsewhere, even in bags, by its mere presence will prevent the ignition of pure coal-dust clouds.

Fact: Actually, rock dust has no effect whatever until it is thrown into suspension in air, where, by diluting the coal-dust cloud and by absorbing heat, it cools the flame and eventually quenches the explosion.

(2) Fallacy: Rock dusting along mine entries need not be continuous and uniform; deficiency of incombustible in one place can be compensated by excessive rock dust elsewhere in the entry; and the incombustible contents of mine-dust samples from several locations can be averaged to determine compliance with the required minimum 65-percent limit.

Fact: Since a coal-dust explosion in a mine entry is progressive and dynamic rather than localized, there can be no compensation for rock-dust deficiency and no dependence on averaging of sampling data. When the explosion flame reaches an area that lacks incombustible it is intensified, and it cannot anticipate extra rock dust farther along its path.

(3) Fallacy: Abundant "blanket" rock-dust application on the floor of mine entries is capable of compensating for partial (and even complete) lack of rock dusting on the rib and roof surfaces of entries. At other mines it is thought sufficient to apply rock dust on the rib and roof surfaces but to leave the floor not at all or only insufficiently rock dusted.

Fact: These practices are highly dangerous, particularly the former. Experiments have shown that, whereas under certain conditions a small deficiency in rock dust on the floor can be compensated by excess rock dust on rib and roof surfaces, the reverse is not true.[4] Since dust, particularly coal dust, is much more readily dispersed off rib and roof surfaces than rock dust can be dispersed off the floor and raised into suspension, it is quite possible for a widespread explosion to develop in a heavily blanket-rock-dusted mine where the rib and roof surfaces are neglected.

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[4] Hartmann, Irving, Nagy, John, and Christofel, F. P., Incombustible Required on Floor and on Rib-Roof Surfaces of Coal Mines to Prevent Propagation of Explosions: Bureau of Mines Rept. of Investigations 5053, 1954, 7 pp.

(4) Fallacy: Rock dusting is important only in the vicinity of active working faces.

Fact: This idea is incorrect. Although most ignition sources occur near face areas, and most explosions have been initiated there, quite a number of ignitions started in entries far from face areas, and owing to insufficient rock dusting some developed into widespread explosions.

(5) Fallacy: Rock dust is needed only in dry areas of coal mines, because in damp and wet sections the coal dust is harmless and the rock dust cakes and loses its effectiveness.

Fact: It is true that moistened and caked limestone is less dispersible and less effective than dry limestone. However, some mine areas become alternately damp and dry many times a year, and it would be wrong to leave them without rock dusting; it takes considerable moisture, not mere dampness, to prevent dispersions and explosions of coal dust; moistened rock dust adheres to and thus reduces the dispersibility of coal dust from the mine surfaces, and after partial or complete drying the rock dust regains its dispersibility at least in part.

(6) Fallacy: A coal-dust explosion that originates in a short, non-rock-dusted area can be stopped instantly or within a very short distance after it reaches a rock-dusted section of an entry.

Fact: Actually such explosions cannot be quenched immediately but will propagate 100 to several hundred feet in the rock-dusted zone before the flame is extinguished.

(7) Fallacy: Rock dust need not always be applied to within 40 feet of coal faces in rapidly advancing entries, but an application once daily will suffice, leaving at times 100 to 300 feet of entry unprotected.

Fact: Actually, experiments indicate that explosions that are permitted to develop for such distances before entering rock-dusted zones might become very violent and propagate for 1,000 feet or more, even when the protected zone contains much more than 65 percent incombustible.

(8) Fallacy: "Dustless" zones in entries are effective in stopping explosions.

Fact: No part of an entry in an operating coal mine can be maintained entirely free of coal dust. Furthermore, experiments prove that strong explosions can readily propagate through several hundred feet of nearly dust-free entries.

(9) Fallacy: When mine dust contains 65 percent incombustible, this provides a considerable factor of safety against coal-dust explosions.

Fact: This is not so. Proper application and maintenance of rock dusting to the extent of 65 percent incombustible content will prevent nearly all widespread mine explosions in bituminous-coal and lignite mines. Experiments and experience have shown, however, that when rock dusting is not carried to within 40 feet of the face, when rock dust is not applied on roof, ribs, and floor, when there are unprotected sections along the path of the explosion, or when the incombustible content of the dust is permitted to drop 10 percent or even less, it may then be most difficult if not impossible to stop explosions in rock-dusted zones with 65 percent incombustible content.

(10) Fallacy: Ordinary ventilation stoppings in crosscuts between intake and return entries of mines are effective in preventing propagation of explosions into or out of back entries.

Fact: Actually, most such stoppings will not withstand pressures higher than 1 to 2 pounds per square inch, and they are easily destroyed, even by weak coal-dust or gas explosions.

(11) Fallacy: A few water sprays used during cutting and loading at the coal face are capable of allaying nearly all fine coal dust at its source, so that no float dust is transported by the mine currents and therefore re-rock dusting of entries is not needed.

Fact: Although sprays used at present near coal faces do much good, they are not effective in preventing dissemination of large quantities of the finest and most explosive coal dust, which should be neutralized by periodically applied fresh rock dust.

(12) Fallacy: All inert materials in mine dust are as effective as limestone and other approved rock dusts of specified fineness.

Fact: Actually, inert sand, shale, and some other inerts frequently encountered in mine dusts are not as effective against explosions as limestone, chiefly because the particles composing these inerts are much coarser.

ROCK-DUST REQUIREMENTS IN COAL MINES

The amount of rock dust needed to neutralize coal dust in a mine depends on the production of coal dust and particularly on the quantity of coal dust left below ground, on the incombustible content of the coal dust, and on the amount of fine incombustible rock or clay material that mixes with the coal dust.

The production of coal dust is inherent in the mining process; it is produced during cutting, drilling, blasting, loading, haulage, man travel, and spalling of coal ribs. The quantity of coal dust produced varies greatly with the type of mining and with the nature of the coal seam and the surrounding strata.

In continuous mining operations, nearly all the coal is reduced to minus-1-inch size, and as much as 20 percent of the total product might pass through a No. 20 U. S. Standard sieve; this fraction can propagate a coal-dust explosion. However, there are still comparatively few mines where continuous miners are used. As an illustration of a more typical condition, consider, therefore, a well-managed mine in a high-volatile coal seam that is 64 inches thick. This mine produces 12,000 tons of coal daily, working on 3 shifts. Part of the production is obtained on retreat and part on development, using an 8-entry (6- by 14-feet) system. The mine roof is supported with bolts. The coal is undercut and shear cut, and it is brought down with Airdox. It is mechanically loaded into shuttle cars, which in turn load 6- to 9-ton mine cars to a level 18 inches above the car top. To allay dust, water sprays are used during cutting and drilling and at transfer points.

At this mine 25 percent (3,000 tons) of the coal produced is minus-3/8-inch size. Of this, 25 percent (750 tons) passes through a No. 20 sieve. Assuming that 90 percent of this dust is loaded out and 10 percent (75 tons daily) remains underground, it would take nearly 150 tons of rock dust to neutralize this explosive coal dust. This is equivalent to 25 pounds of rock dust per ton of coal produced. Actually, at this mine 7 pounds of rock dust now is used per ton of coal (last year less than 2 pounds per ton was used). This is a daily consumption of 42 tons of rock dust, an amount sufficient to neutralize about 25 tons of coal dust. This means that 97 percent of all the minus-20-mesh coal should be removed from the mine, which is most difficult to accomplish. Inherent incombustible in the coal and the inert dust from the roof and floor strata may help to neutralize some additional coal dust; but this may be offset by coal dust produced by sloughing of ribs and by disintegration of larger pieces of coal that are not removed initially from the mine.

In considering this problem it should be pointed out that the vast majority of coal mines use less than 5 pounds of rock dust per ton of coal and that part of this rock dust is frequently misapplied, as by excessive "blanket" rock dusting of the floor in certain entries. In the mine under discussion, about 3 tons of coal is mined per linear foot of entry. This means that an average of 21 pounds of limestone dust is applied per foot; if, for the moment, limestone dust applied on the rib and roof surfaces is not considered, this represents a layer of limestone 0.3 inch thick on the floor. In some coal-mine entries limestone is applied on the floor to a depth of 2 inches and more; a 1-inch layer of limestone 1 square foot in area weighs about 5 pounds. If in a 100-foot-long section of a 14-foot-wide entry limestone is applied to a depth of 2 inches (140 pounds per linear foot), it means that, if the seam is about 62 to 64 inches thick and the average consumption of rock dust is 7 pounds per ton of coal, about 600 feet of entry in another section of the mine would be left without any rock dust whatever.

Consider next the float-dust problem at this mine. As stated earlier about 750 tons of minus-20-mesh coal dust is produced daily. Of this, normally about 20 percent, 150 tons, will pass through a No. 200 sieve, a fraction that is highly explosive. Assuming that 1 percent (1.5 tons = 3,000 pounds = 48,000 ounces) of this fine dust is transported and deposited along the entries by the air current as float dust, this amount of dust, if uniformly distributed, would daily provide a lower explosive-limit mixture (0.05 ounce per cubic foot) in 960,000 cubic feet of entry volume, or in about 1,400 feet in each of the 8 parallel entries. Of course the distribution of this coal dust is not uniform, most of it being deposited near the active faces. However, the illustration shows the importance of the float-dust problem, because even if only 0.1 percent instead of 1 percent of the through-200-mesh coal dust were disseminated by the air currents, a float-dust deposit equivalent to a lower explosive-limit mixture might cover more than 100 feet in each of the 8 entries daily. If the float dust were uniformly distributed on the ribs, roof, and floor in a 6- by 14-foot (84 cu. ft.) entry, at a concentration corresponding to 0.05 oz./cu. ft., it would be equivalent to 0.1 ounce per square foot of surface, or a dust layer with an average thickness of less than 0.003 inch. It is largely to neutralize this fresh float dust that mine entries should be re-rock-dusted periodically. The foregoing example indicates the importance of making every effort to reduce the formation of fine coal dust during mining and to collect or promote the settling of dust near its source.

IMPROVING THE ADHERENCE OF ROCK DUST ON MINE SURFACES

During normal application with machines, it is often difficult to make the rock dust adhere to the roof and ribs, particularly if these surfaces are dry and smooth.

Tests have shown that, even with normally good adherence, not more than 30 to 35 percent of the limestone dust sticks to the ribs and roof; the balance falls chiefly on the floor, and some is carried away by the air current. A limited number of tests were performed in the Bureau's Experimental coal mine at Bruceton, Pa., in efforts to increase rock-dust adherence.

One series of experiments was based on the idea that successive applications of small amounts of rock dust may result in greater adherence than a single application of a larger quantity. The tests were made in a mine entry 7 feet high and 10 feet wide, with 2 ordinary limestones and 1 surface-treated limestone. The test data are plotted in figure 1. The curves have been drawn from the results of tests with successive applications of small amounts of limestone; the closed circles represent values (ribs and roof) from single applications of 4, 6, and 8 pounds per linear foot, respectively. The data indicate that, from the standpoint of adherence, it is largely immaterial whether a given amount of rock dust is applied in small, successive increments or whether a large amount is applied at one time. The data also show that limestone A adheres to the rib and roof surfaces somewhat better than limestone B, and both of these adhere much better than the surface-treated limestone C.

Another series of experiments was made to determine whether wetting of the rib and roof surfaces might increase adherence of the rock dust. The surfaces were wetted in 2 ways, namely, by directing for a short time a fine water spray against the ribs and roof about 10 minutes before applying the rock dust; and by attaching a spray about 12 inches in front of the nozzle of the rock dust hose, so the water reached the surface just ahead of the rock dust. The water was applied at the rate of 0.15 to 0.2 gallon per linear foot of entry. The two methods of wetting gave nearly identical results. Figure 2 shows how wetting affects the adherence of the ordinary limestone A and the surface-treated limestone C. As can be seen, the adherence of limestone A on the rib-roof surfaces was increased by wetting from 32 to 45 percent; the adherence of surface-treated limestone increased from about 14 to 27 percent.

A few experiments also were made in which dry limestone dust was applied on rib-roof surfaces that had been coated with limestone and subsequently became wet owing to natural conditions. These tests showed that when dry rock dust is applied on such surfaces a very high proportion, ranging up to 50 percent for ordinary limestone, may adhere to the ribs and roof.

The Bureau concludes from this study that, when it is difficult to make rock dust adhere to the ribs and roof of mine entries, these surfaces should be moistened slightly before or during rock dusting. In commercial mines it would be advisable to determine by trial which of the available limestone dusts is most suitable for this purpose and to what degree the ribs and roof should be wetted to achieve the desired results.

WET ROCK DUSTING

The requirement that rock dusting in mine entries be carried to within 40 feet of active coal faces may necessitate the application of rock dust during a working shift. This is particularly true of highly mechanized mines, where continuous miners are used on three shifts and where a face may advance several hundred feet daily. Conventional rock dusting with machines is a dusty operation, and the dense dust clouds may affect the health of face workers and impair expensive mining machines. For this reason, in some mines rock dusting has not paced the advance of the coal faces, and at times long sections of entries are left without rock dust.

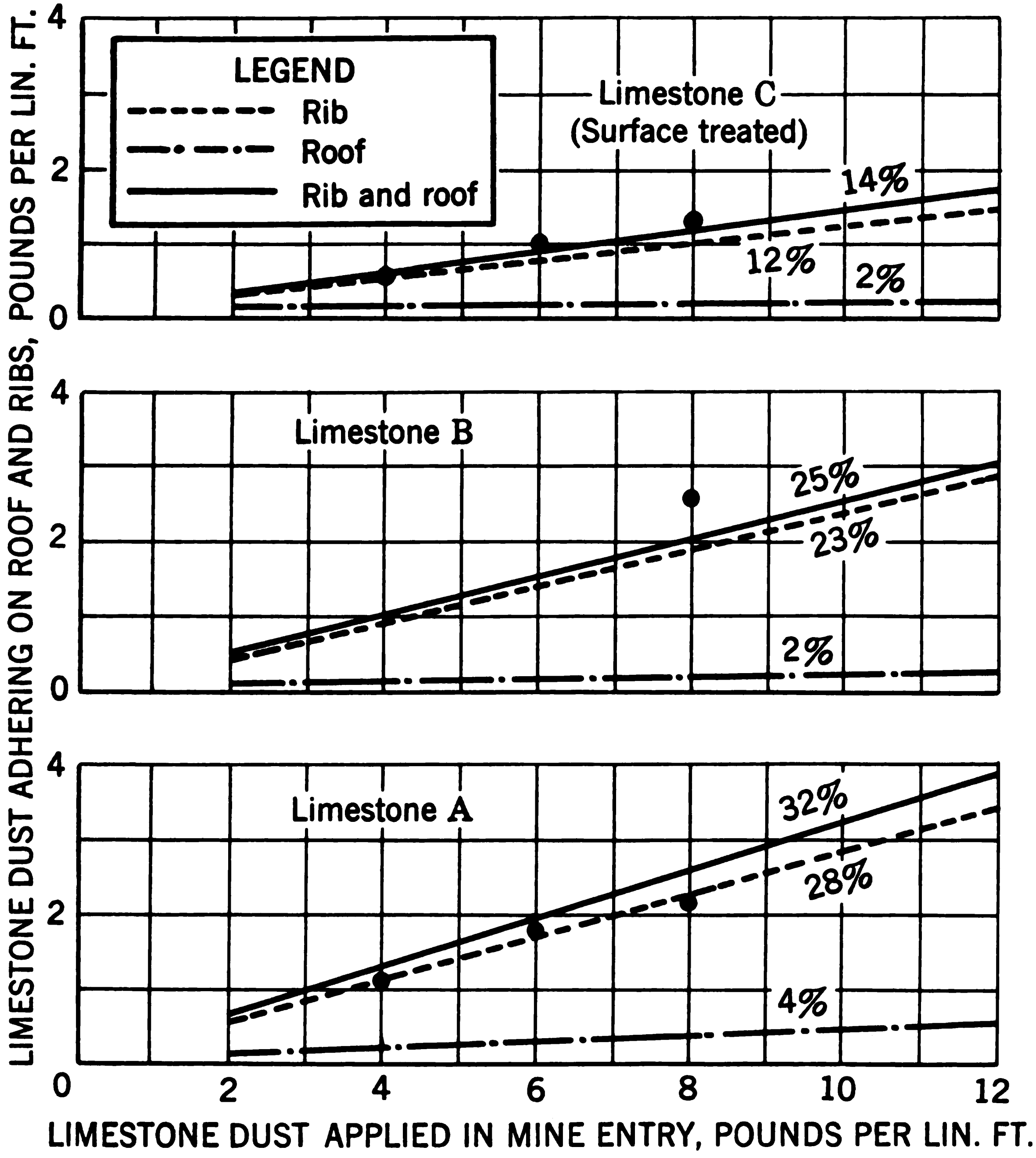

Figure 1. - Adherence of limestone dust on dry roof and rib surfaces of mine entry (7 x 10 ft.).

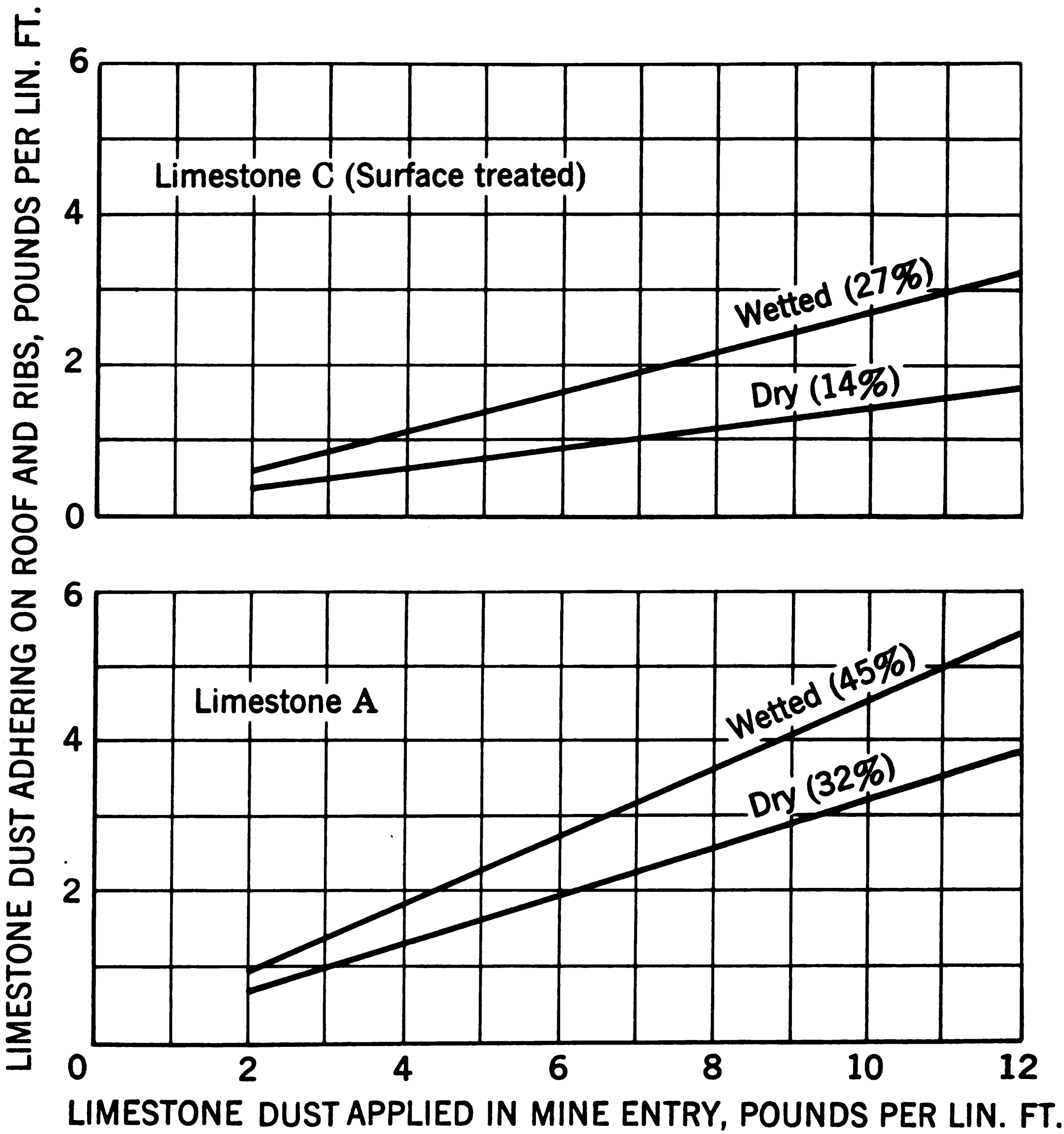

Figure 2. - Adherence of limestone dust on dry and wetted surfaces of mine entry (7 x 10 ft.).

To remedy the situation various substitute methods of rock dusting and other protective measures have been considered. One procedure involves the application of wet rock dust, either in the form of a premixed slurry or by mixing dry rock dust with water at the nozzle of a rock-dusting machine. The problem was investigated recently in the Experimental coal mine. The objectives of part of this study were:

(1) To determine whether wet rock dust could be applied practically in coal-mine entries without creating undesirable dust clouds; to find the proper ratio of rock dust to water; to find the least quantity necessary for a good covering of the rib and roof surfaces; to establish the degree of adherence; and to determine the rate of drying after application.

(2) To study the effectiveness of wetted rock dust, after partial or complete drying, in arresting the propagation of explosions.

The results of the preliminary study showed that:

(1) A premixed slurry of limestone and water fed from a guniting machine through a gunite nozzle can be applied effectively on mine surfaces and will produce very little dust in the air.

(2) Limestone dust fed from a guniting machine or from a commercial rock-dusting machine, mixed with water at the nozzle, can also be applied effectively and produces little dust in the air. A gunite nozzle was found suitable for this purpose. Application with the gunite machine gave a more uniform flow than the small rock-dusting machine, because the feed from the latter pulsated.

(3) A minimum of 4 pounds of rock dust, applied wet, was needed per linear foot of entry (9 to 10 feet wide by 7 feet high) to cover the ribs and roof completely. Six gallons of water mixed with 100 pounds of limestone gave a satisfactory mixture for nozzle application; the slurry required slightly more water. About 85 percent of the wetted rock dust adhered to the rib and roof surfaces.

(4) The rate of drying of the rock dust varied with the humidity and with the velocity of the air current. At normal air flow, at relative humidities below 80 percent, the rock dust dried completely in 1 to 3 days; at humidities of 80 to 90 percent, it dried in about 1 week; and at higher humidities, several weeks were needed for drying.

(5) During dry rock dusting, when the air flow in the entry was maintained at 6,000 cubic feet per minute, the dust count 25 feet downstream from the nozzle was found to be as high as 5,000 million particles per cubic foot of air, and 100 feet downstream the count was about 2,000 m.p. / cu. ft. When the slurry was applied, the dust count was less than 0.5 percent of the foregoing values; when limestone dust and water were mixed by a nozzle, the dust count ranged from 1 to 10 percent of the foregoing values.

The explosion tests were performed in the main entry of the Experimental coal mine. Explosions were initiated at the face of the entry either by a blown-out shot fired from the face into pulverized coal dust or by the ignition of a 25-foot-long gas-air mixture near the face. In most tests the rock-dust (limestone) zone started 50 feet from the face (owing to the physical layout in the entry a 50-foot rather than 40-foot zone was used), and it extended several hundred feet along the entry. On the floor of the rock-dusted test zone dry rock dust was distributed by hand in several tests, but in a few tests this was not done. In several tests rock dusting was begun 100, 150, or 200 feet from the face; the portion of the entry between the zone of ignition and the start of the rock-dusted zone contained pure coal dust, or in a few cases it was a "dustless" zone.

After application and drying of the wetted rock dust, a small amount of coal dust was distributed by hand over the rock-dusted surfaces. The aim was to simulate operating conditions in a coal mine, where fresh float dust is transported by the air current and deposited in the entries daily. To serve as a basis for judging the effectiveness of wetted rock dust, several tests were made with dry rock dusting. The results of the explosion tests indicated that:

(1) Dry rock dusting was more effective than wetted rock dust in arresting the propagation of explosions.

(2) Wetted rock dust was somewhat more effective after complete drying than after partial drying.

(3) Dry rock dust distributed on the floor in entries where wet rock dust had been applied on rib-roof surfaces helped greatly in limiting explosion propagation. The incombustible content of the floor dust should in no instance be less than 65 percent.

(4) The explosions were readily arrested when the rock-dusted zone started 50 feet from the face, except in 1 test in which finely pulverized coal dust at the rate of 1 pound per linear foot of entry (forming a cloud of 0.25 oz./cu. ft. concentration, if all were dispersed) had been applied over the wetted rock dust.

(5) When rock dusting was started within 100 feet of the face, difficulty was encountered in stopping some explosions; when the rock dust zone started 150 or 200 feet from the face, it was most difficult if not impossible to stop explosions.

SAMPLING MINE DUST

Sampling in Normally Rock Dusted Areas

The purpose of collecting and analyzing mine-dust samples is to determine whether, in a given area of a coal mine, the dust contains sufficient incombustible; that is, a minimum of 65 percent, to prevent the propagation of coal-dust explosions.

A few years ago an intensive sampling survey was conducted by the Bureau in an Indiana coal mine, and simultaneously less thorough sampling data were obtained at several Pennsylvania coal mines.5/ Largely as a result of this study the practice by Federal inspectors of collecting separate road and rib-roof samples at each location was supplanted by the collection of a complete band or perimeter sample (in a strip 6 inches wide) from the roof, the ribs, and the top 1-inch-deep layer of the floor dust. After the sample is collected the coarse fraction is removed by separation on a 10-mesh screen. If the sample is too large, it is mixed and quartered successively until reduced to the amount desired for shipment to the analytical laboratory.

At the foregoing mines, rock dust had been applied in the normal manner on the rib and roof surfaces, as well as on the floor. The sampling data showed that the

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5/ Hartmann, Irving, Nagy, John, and Rauschenberger, J. K., Lessons From Intensive Dust Sampling of a Coal Mine: Bureau of Mines Rept. of Investigations 5054, 1954, 12 pp.

incombustible content in the rib-roof dust was nearly always higher than in the road dust and that the incombustible content of band samples was only slightly higher than the incombustible in the corresponding samples of road dust. It was felt, therefore, that overall protection against propagation of dust explosions will not be jeopardized if band samples are collected and these are required to contain at least 65 percent incombustible material. The entries of the Indiana coal mine had been rock dusted several times, and the test data showed that the incombustible content of the top 1-inch layer of dust on the road closely approximated the incombustible content of full-depth dust samples; the thickness of dust ranged up to 4 inches in a few places.

Since completing the foregoing study, the Bureau of Mines has found that in certain coal mines rock dusting of the rib and roof surfaces is neglected greatly or completely, and in other mines very little, if any, rock dust is applied on the floor. In some mines rock dust is applied once, but little attention is given to re-rock dusting of entries. In view of this experience, the Bureau of Mines now is reexamining the advisability of resuming collection of separate road and rib-roof samples, at least in some locations; and it plans to collect additional data on the incombustible content of thick dust deposits on mine floors. The Bureau would, of course, greatly prefer to see such deposits eliminated. Another factor that requires further study is the collection of dust samples in damp or moist areas of coal mines. Experiments have shown that somewhat moist coal dust upon dispersion is fully capable of propagating explosions, yet owing to some difficulties few dust samples are normally taken from such places.

The location and number of sampling points at present depend largely on the time and judgment of the Federal mine inspector. Many duties important to the complete inspection of a coal mine prevent the collection of a large number of samples; inspectors depend to a great degree on visual estimation and past experience in judging the rock-dust conditions in mines. This is not difficult in areas that are obviously very high or obviously greatly deficient in incombustible content. The theoretical minimum number of dust samples needed to give reliable information on the average incombustible content in mine workings depends on the uniformity of the rock-dust application, as indicated by the standard deviation of the incombustible content of the samples from the arithmetical mean. Frequency-distribution curves prepared from band-sampling data at 17 recently inspected coal mines in Virginia, West Virginia, and Kentucky (1,021 samples) indicate that the minimum number of samples needed in order that the average incombustible content should be within a desired probable error of ±5 percent of the true average, with a certainty (or confidence) of 90 percent (or 95 percent), is 21 (or 27); if the probable error is reduced to ±2 percent the number of samples is 118 (or 167). In comparison, information based on band samples collected at the earlier mentioned Indiana mine (417 samples) yielded, respectively, values of 25 (or 36), and 156 (or 223).

Sampling Wet-Rock-Dusted Areas

In areas of coal mines where wet rock dust has been applied on the rib and roof surfaces and dry dust distributed on the floor, separate road and rib-roof samples should be taken. The road samples should be collected in the same manner as in normally rock dusted entries. The best procedure for sampling the ribs and roof has not been established yet, and a study of this problem is in progress.

The adherence of wetted rock dust to mine surfaces is better than that of dry rock dust, but its dispersibility and its mixing with coal dust are less complete. For this reason, the potential hazard of a superficial layer of float dust on the

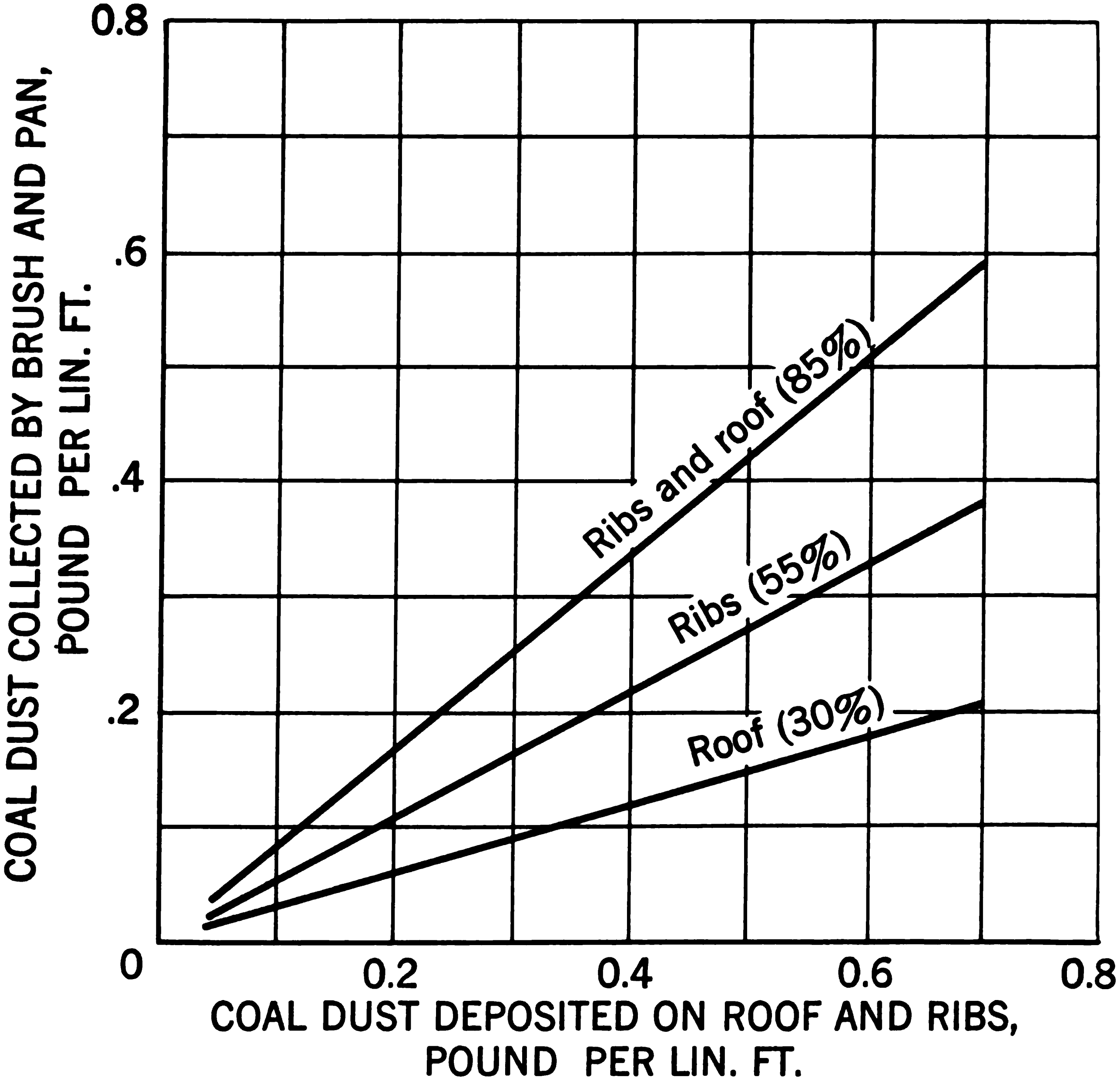

Figure 3. - Adherence of coal dust on wet rock-dusted roof and rib surfaces of mine entry (7 x 10 ft.).

rock-dusted surfaces will be greater than in normally rock-dusted areas. In weak explosions this float dust, but little if any of the rock dust beneath it, might be dispersed, and the explosion could propagate for a long distance.

Pending outcome of the current study, the Bureau recommends that a close check be kept on the condition of wet-rock-dusted surfaces. It should be noted that when the rock dust begins to spall appreciably off the ribs and roof this indicates that fresh rock dust should be applied. It should also be observed at what rate float dust is being deposited. This can often be noted visually by darkening of the rock-dusted surfaces. In addition, float dust might be collected on horizontal trays of known areas, attached at various locations near the ribs. From the weight of the dust, the amount deposited per unit area of the entry surfaces can be computed and from this information the average concentration of float dust per unit volume of entry determined. When this concentration reaches about one-half of the lower explosive limit of coal dust, that is, a value of 0.025 oz./cu. ft., serious consideration should be given to applying fresh rock dust in the area.

Another way to check the rate of float-dust settling is to collect 6-inch-wide strip samples from the ribs and roof by the brush-and-pan method. In this procedure only the superficial deposit of coal dust should be collected, and inevitably some rock dust with it; care must be taken not to remove and disintegrate any coal or rock from the solid ribs and roof. The accurate weight of this sample should be obtained and its incombustible content determined. From this information the weight of coal dust per unit length of entry and the concentration per unit volume can be computed. As indicated in the previous method, when the concentration of the superficial coal dust reaches about one-half of the lower explosive limit, the area should be rock-dusted anew; this should be done regardless of the incombustible content of the collected dust samples. In areas where the rock dust fails to dry completely, if care is exercised a wire brush rather than a hair brush can be used for removing the surface dust from the ribs and roof.

To study the feasibility of this method of checking float-dust deposition, experiments were performed in a fairly uniform part of an entry in the Experimental coal mine on which wet rock dust had recently been applied. Pulverized coal dust was broadcast carefully at the rates of 1/8, 1/4, 1/2, 1, and 2 pounds per linear foot in adjoining parts of the entry. The floor had been covered with large sheets of paper, and the dust falling thereon (55 to 70 percent of the amount applied) was collected and weighed. Then numerous strip samples were taken separately from the ribs and from the roof; in some instances a fine brush was used and in others a wire brush. The ventilating current was stopped during the distribution of the coal dust and during the sampling.

The test results (plotted in figure 3) show that a very high proportion (an average of nearly 85 percent) of the (float) dust deposited on the ribs and roof can be collected by this method; in the tests, approximately one-third the dust was collected off the roof and two-thirds off the ribs. In this entry a lower explosive limit mixture corresponds to a coal-dust deposit of about 0.22 pound per linear foot on the roof and rib surfaces; the dust deposited on the floor is not considered because it is expected that this will be neutralized by dry rock dust.